

PROGRESS REPORT
OF
FOREST RESEARCH WORK IN INDIA
FOR THE YEAR 1919-20
(FOREST YEAR)

Including the Administration Report

OF THE
FOREST RESEARCH INSTITUTE
Dehra Dun

ALLAHABAD
THE PIONEER PRESS
1920

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INTRODUCTION.

If this annual report in its revised form is to serve the purpose which is desired it will bring to the notice of forest officers interested in silvicultural and other kinds of development the work which is being done in all the provinces and, although it may be in an abbreviated form, the dissemination of ideas, especially those which are proving successful, under one cover will surely save the time and effort of those who are groping their way and thereby make far more rapid progress than has been possible in the past. The first report of its kind is necessarily deficient. It is certain that the reports of future years will gain in fullness and value if the central Forest Research Institute and the Provinces all combine to make them so.

What follows under the main heads of research is inevitably an almost word-for-word compilation from the information furnished by the different reporting officers.

CHAPTER I.

GENERAL.

The development of forest research and its organisation in India, which has been taking shape during the past few years, partly on account of a better appreciation of the need of the scientific study of our resources and in part as a result of the extraordinary demands of the war, has gone forward a good step during the year.

The enlargement of the central Research Institute at Dehra Dun has been under consideration for the last four years, and a scheme entailing an expenditure of 30 lakhs has now been sanctioned by the Secretary of State. This scheme will involve the transfer of the present Institute to a new site and for this purpose possession was taken of 1,337 acres of very suitable land just as the year was closing. The five main branches of the Institute remain the same, but with the exception of the silvicultural branch all will gradually undergo very considerable expansion at Dehra in personnel as well as in plant and materials. The silvicultural branch, as is inevitable from the great amount of local work to be done, is being partially decentralised from Dehra, and the latter will eventually be left chiefly as a co-ordinating and advisory centre for the work of the Provinces; this decentralisation will not diminish the responsibilities of the central Silviculturist.

The principal directions of the enlargement of the economical branch at the central Institute are towards obtaining a greater knowledge of the technical properties of the Indian timbers and prolonging their life in various ways which have been studied much more closely in the United States of America and Canada, as well as the study of pulp and paper possibilities on a semi-commercial scale.

Still greater changes are taking place in the Provinces. On 1st January 1920 new Forest Circles of Working Plans and Research work were instituted both in Burma and the United Provinces, while on the 1st February a Utilisation Circle, such as had previously existed in the United Provinces, was added in Burma. These Provinces had previously each had a research officer or silviculturist.

It is planned to establish a complete research institute in Burma which will keep in touch with the central Institute. While research work in the properties and use of timbers will be undertaken in the moist heat of Lower Burma and at the big commercial timber centre of Rangoon, it is intended to place the Burma Forest Research Institute in Maymyo and for this purpose plans have been prepared and the site is being cleared. No officers have been appointed yet but on the return of those now on leave it is proposed to create posts of silviculturist, botanist, and entomologist and a chemist will also be engaged in due course. The Institute itself will provide office and laboratory accommodation for these officers and their staff, and will also house the herbarium and a reference library and accommodation for photographic work.

The deputation of special officers for the investigation of silvicultural problems took effect both in Madras and in Bengal during the year. Each of these also has a utilisation officer. Forest research is claiming attention in other provinces as well, as is evident from the account of the investigations under way and in some at least the failure to appoint special officers is due solely to the extreme shortage of staff.

These few words will be a sufficient introduction to the work done during the year in the central Institute and in the Provinces, as reported to this office.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

CENTRAL INSTITUTE.

Statistical.—Owing to the absence on leave of the Silviculturist, plot work, ledgering, and experimental work were considerably in arrears when Mr. Howard took over charge in October and a large amount of time has been spent in bringing these two items up to date. Plot work is not completely up to date yet but it will be so before the touring season of 1920 begins. Ledgering is practically up to date. Experimental work is always rather behind hand owing to the impossibility of carrying it out from Dehra Dun but with the appointment of local silviculturists this branch of research should make more headway than hitherto.

During the year 26 sample plots were remeasured and 7 new ones inaugurated and 24 experimental plots inspected. There are now 294 sample plots and 76 experimental plots distributed among the various provinces which have been set out by officers of this Institute.

The methods and forms approved by the Board of Forestry in 1919 have been used entirely in remeasurements this year and at the same time the old measurements made under the former methods have been corrected as far as possible. Besides the above a large number of old measurements on plots not due for remeasurement have also been corrected to the new method.

In order to make these corrections it was not sufficient merely to substitute the diameter equivalent to the measured girth and convert the volume calculated from Troup's quarter-girth volume tables into volumes calculated under the πr^2 method as this would still contain any error introduced by girth measurement. In order to ascertain this error all recently-remeasured plots were measured both by girth and diameter and the error calculated therefrom. The species so measured were sal and deodar. It was found that the *average* error for both species is a constant and the same constant for each. It is possible that the constant will not be the same exactly for other species but the difference is likely to be exceedingly small and it is thought that the constants found may be used by local

The small experiments at Zabarkhet, a large blank in the sal forest near Lachiwala, which is also a frost hole, have passed into the next stage. So many of the results depended on intensive weeding in the rains, which is often not possible under the local conditions prevailing in Dehra Dun, that this has been ruled out for further work. It appears from the former small experiment that chir pine (*Pinus longifolia*) sowings do better unweeded than weeded, while sissoo (*Dalbergia Sissoo*) sown in December on clear ground are a foot high before the rains break and the grass comes, and root and shoot cuttings of sissoo put out in December on clear ground are 3 feet high before the rains break.

The present experiments are reduced in number but on a larger scale than those of the preceding year. They consist of an acre of chir pine sowings on land ploughed up before the rains which will now be left untended, secondly half an acre of sissoo which will be sown in December and then left, and thirdly $3\frac{1}{2}$ acres of root and shoot cuttings of sissoo which will be put out in December and then left untended. In addition two smaller experiments of $\frac{1}{4}$ acre each have been started, one planted with bamboo (*Dendrocalamus strictus*) seedlings and the other sown with *Bulca frondosa*. Although chir pine is out of its natural habitat here it is considered a legitimate species to try since so long as some crop is induced to grow in this frost hole, it matters little what it is.

It is hoped that these experiments are large enough to allow of conclusions of practical worth being drawn and if successful they will be extended next year.

The experiments of tan-yielding trees and shrubs, which are mentioned in last year's report, are incomplete. That concerning *Anogeissus latifolia* will best be completed in the Provinces, since the difficulty lies not in obtaining the pollard shoots but in protecting the young shoots from damage by monkeys and browsers.

Period of Growth.—An experiment was started last December to find at which period height growth occurs in the species available here both exotic and indigenous. It appears so far that in Dehra Dun for seedlings up to three years old December to February is a period of rest and often up to the end of March. Vigorous height growth then begins and continues till the end of June. At present it is not known what happens after that.

Other Experiments.—Various other experiments regarding sowing, transplanting, cultivating camphor for yield of leaves, and the cause of twisted fibre in the chir pine (under Mr. Champion's direction) continue in Kaunli garden.

Tours.—The Silviculturist spent 136 days on tour, visiting Kulu, Haldwani, Changa Manga, Bengal and Jaunsar.

Photographic Records.—The photographic branch contains 3,567 photographs, 3,448 negatives, 450 lantern slides and 12 coloured transparencies.

Publications.—No publications have been actually issued during the year but apart from those mentioned in the list of publications a single tree yield table for first quality sal in Bengal has been worked out from measurements of single trees made on tour in Bengal and will appear shortly.

UNITED PROVINCES.

Statistical.—The Research Division laid out 16 permanent sample plots of *Holoptelea integrifolia*, *Shorea robusta* and three principal hill species. Most of the old divisional sample plots have been abandoned but a few are kept up and their figures will be of use later on when the time comes for preparing yield tables.

Natural Regeneration of Sal.—Numerous experimental 1-acre plots in the plains and submontane divisions were made in the 1918 seed year to see the effect of leaf burning and preliminary soil working on sal regeneration, and another plot of 1913 seedlings in the Haldwani Division remained under observation. While seedlings in adequate numbers become established and persist when climatic and other conditions are favourable, their subsequent progress without further tending is shown to be very slow. Even though the weeds are cut back yearly in the 1913 plot in the cold weather the 7-year-old sal plants do not exceed 2 feet in height yet. In the very unfavourable locality of the Jaspur Range, Ramnagar Division, special experiments were continued on the lines laid down by Mr. Hole, Forest Botanist, i.e., clear-felled strips were made in the forest, the grass and litter burnt, and either sal seed sown or the strips left to natural seed. No rains weeding or subsequent tending has been made. The results obtained are frankly disappointing, as out of 20 strips, 18 have failed entirely. It may be regarded as definitely established that simple clear

felling in strips is not the solution of the problem of sal regeneration in these forests. Probably clear-felled strips, combined with weeding and soil loosening in the rains, would give better results, but it is thought the cost would be prohibitive.

A striking contrast to the above is afforded by the experimental patch of sal plants at Chorgalia (Haldwani Division). The sal seed was sown in June 1915 on prepared fertile loam in the open, weeded and tended the first year, and subsequently irrigated each hot weather. In January this year the plot was measured and the best plants found to exceed 16' in height.

To summarise the results of experiments and observations in the United Provinces, successful establishment and rapid development of sal seedlings appear to depend chiefly on—

- (a) Good soil aeration.
- (b) Good moisture content in the soil.
- (c) Freedom from competitive weed growth.

Other things being equal, where one or more of these factors is unfavourable results will be correspondingly poor.

Artificial Regeneration and General Silviculture of Miscellaneous Bhabar Species.—The increasing commercial importance of numerous Bhabar species, among which may be mentioned *Dalbergia Sissoo*, *Adina cordifolia*, *Holoptelea integrifolia*, *Bombax malabaricum*, *Acacia Catechu*, *Albisia procera*, *Garuga pinnata*, *Odina Wodier*, *Hymenodictyon excelsum*, *Anogeissus latifolia*, *Lagerstrœmia parviflora* and bamboos, has necessitated a careful study of the principal factors affecting their regeneration, and a large number of experiments have been started this year, both in small experimental plots and in large scale plantations, the results of which will be recorded next year. Hand in hand with the experiments on their artificial regeneration, observations have been made on the silviculture of these forests and these are being published in a Bulletin.

Afforestation.—A considerable amount of research and experiment was carried out in the Afforestation Division during the year, which may be briefly summarised as follows :—

(i) *Introduction of New Species.*

Holoptelea integrifolia, *Terminalia Arjuna*, and *Gmelina arborea* were extensively sown and gave very promising results. *Anogeissus latifolia*, *Adina cordifolia*, and *Cedrela Toona* failed.

Roots of sal, bamboos and various grasses of the drier submontane forests were planted out experimentally. The sal failed entirely, bamboos were only partially successful, but the grasses showed signs of being successfully introduced by this means.

(ii) Employment of Famine Labour in Ravine Reclamation.

The reclamation and afforestation of ravines by famine labour was tried during the year on a large scale and proved in every way highly satisfactory. The substitution of manual labour for mechanical cultivation increased the cost by no less than 200 %, but famine works being designed to employ the maximum manual labour of every description are necessarily costly and often of doubtful utility. In the case of ravine reclamation every class of labour can be employed, the work can be expanded, curtailed, or closed down at any time without leaving it incomplete and the shifting nature of the work makes it highly sanitary. Furthermore, the work is an insurance against future fodder famines as it is a direct means of encouraging and developing local grass reserves. The actual work done was of a very high standard. In future famines, it seems probable, that very extensive afforestation work will be done by famine labour.

Twisted Fibre in Pinus longifolia.—Mr. Champion continued his investigations on this subject. Research up to date indicates that the tendency to spiral fibre is inherent in the seed. This conclusion agrees with that of Professor Toumey of Yale University who investigated the same phenomenon in *Pinus Jeffreyi* in the mountains of Colorado. A paper will be published on this subject when the investigation has proceeded further; it is of great importance in Kumaon and possibly elsewhere also.

Publications.—Besides the record noted in Chapter VII "Enumerations of miscellaneous species of the Ramnagar and Kalagarh Divisions" by A. Smythies was put into print.

BIHAR AND ORISSA.

Regeneration.—A few experiments in the regeneration of sal are reported but they have not proceeded far and no conclusions can be drawn from them.



Photo-Mech. Dept., Thomason College, Noertee.

Photo by T. B. Chitrakas.

A *Sal taungya* in its third year; Nimati sowing of 1917, Buxa Division. Area 11 acres.

Plants 30 months old - average height 3 feet. This area contained some grass before regeneration and there is still some there.

BENGAL.

Regeneration.—Excellent progress continues to be made in solving the problem of regenerating the fire-protected sal forests of the Bengal Terai by means of the combination of forestry with agriculture. Long continued fire-protection has resulted in a heavy evergreen undergrowth rendering purely natural regeneration impossible. A forest record of this work will be published shortly.

The whole subject is also dealt with in a comprehensive manner in his "Note on a tour of inspection in the Goalpara (Assam), Buxa, Jalpaiguri, Kalimpong and Kurseong Divisions (Bengal)," June 1920, by Sir George Hart, Inspector-General of Forests. To quote from the latter and put his conclusions briefly—the object of the experiments in Goalpara is to get rid of the evergreen, replace it by bata grass and then induce natural regeneration of sal. Annual cutting back of the undergrowth and firing in the hot weather during the past five years have given partially successful results. The main idea of these experiments is to continue annual burning until the last traces of the evergreen undergrowth have been removed, then to restart fire-protection which, with some lightening of the sal overwood will, it is believed, cause the bata grass to thin itself out and bring about conditions favourable to the natural regeneration of sal. The Inspector-General continues:—"I am not very hopeful that treatment on these lines will ever result in our obtaining really adequate natural regeneration of the sal in these forests. The officers in the adjoining Bengal Divisions, who have been studying the problem for years past, do not believe in it and pin their faith on clear felling followed by artificial regeneration, either with or without field cultivation, as may be possible, the sal and other species being used to suit soil conditions. I believe they are right; but as the difficulties to be overcome in Goalpara would be much greater than they are in Bengal the importance of the regeneration experiments to be carried out in the former during the next 10 to 15 years can hardly be overrated, as the future treatment of the forests will depend on their results. For this reason it is very desirable that the sanctioned appointment of a local Silviculturist should be filled as soon as possible and that the work should be entrusted to the officer selected for this post." In the four Bengal Divisions the area of *laungya* plantations thus made in the last five years is 1,450 acres.

The chief difficulty is to get enough labour to work on forest village terms and carry out the field cultivation thoroughly. Where sufficient labour is available both for cultivation and subsequent tending the cost of the artificial re-stocking of the forest should not exceed Rs. 15 per acre. The other lessons of the last five years' work are thus summarised by the Inspector-General of Forests :—

- (i) It is useless to attempt to re-stock grass land without field cultivation.
- (ii) Wire fencing, proof against pig and deer, is essential in order to protect the villagers' field crops and the young forest crop. This fencing must be provided by the Department.
- (iii) In the case of sal two years' field cultivation is essential. In the case of other quicker growing species the second year's cultivation may often be dispensed with if the first year's work has been done thoroughly.
- (iv) Sal plantations should be limited to soils which are obviously suited to the production of sal timber of good quality. In other localities the quicker growing soft-wooded species can be raised with less difficulty and are likely to give better financial results. These species include *Cedrela Toona*, *Bischofia javanica*, *Dalbergia Sissoo*, *Bombax malabaricum*, *Michelia Champaca*, *Amoora Wallichii*, *Duabanga sonneratioides* and others. (*Vide Plate 3.*)
- (v) The mixture of species by individuals is not likely to be as satisfactory as the mixture in strips and small blocks.
- (vi) With the sal, sowing in lines is preferable to sowing in patches (*talli*), owing to the greater effect of the former in killing out the heavy growth of grass which follows the cessation of field cultivation.

The best sal plantations have made 10 or 12 feet of height growth in three years from seed.

Assam.

Regeneration.—The principal experiment in the Goalpara Division has already been referred to. In the Eastern Circle of Assam the want of data regarding the natural regeneration of the more important species, in the evergreen forests has, in three cases rendered it

impossible to revise working plans so as to be of any real value; hence experimental regeneration fellings have been started in the Lakhimpur and Sibsagar Divisions to determine the best methods of inducing and aiding the seedlings of the more important species, more especially sal, Hollong (*Dipterocarpus pilosus*), Nahor (*Mesua ferrea*), Ajhar (*Lagerstroemia Flos-Reginae*), Hollock (*Terminalia myriocarpa*), Poma (*Cedrela Toona*) and Bonsum (*Phoebe Hainesia*). The solution of these problems is the more necessary because some of the finest forests in East Assam are about to be leased to big timber firms and it is proposed to work them under a method of concentrated fellings. During the year the two Extra Assistant Conservators of Forests on special duty collected some useful information regarding the germinating power of the seed of the principal species and the most suitable method of sowing them. Generally speaking, the Conservator writes, the natural regeneration of these species is satisfactory, and it is hoped that by means of thorough and repeated climber-cutting and a certain amount of cleaning it will be possible to regenerate the areas over which fellings will be carried out without having recourse to artificial work to any great extent.

Mr. R. N. De's experiments at Tingrai in the proposed extension of the Upper Dehing Reserve in Lakhimpur Division have been mostly in connection with the re-stocking of exploited areas artificially. Three blocks of forest each 10 acres in area were selected in Dipterocarp and Mesua forest and all undergrowth up to 9" in girth and bamboos (*Pseudostachyum polymorphum*) were felled and climbers cut. In the first block enough trees of exploitable size and saleable species were left to form a canopy giving an even distribution of light and shade. In the second all such trees were removed without any attention being paid to spacing for light and shade, this experiment illustrating the regeneration of "such a forest as we may expect to find when the Assam Railway & Trading Co. will have finished their fellings and extraction, working under a scheme of concentrated fellings." In the third block all trees of inferior species up to 4' in girth which are not required to give shade were felled. Parts of these areas were sown up with seed of half a dozen valuable species at the end of April 1920, in patches 13' x 13', a large number of seeds being sown in each patch. The Dipterocarp seed had been collected in January and February, and by April while 40 per cent of

It had been destroyed by insects nearly all the rest had lost its germinating power. Some of the same lot sown in the 3rd week of February germinated with a percentage of 66. The Extra Assistant Conservator (Mr. De) has noted that there is plenty of natural regeneration of Hollong (*Dipterocarpus pilosus*) in the forests and in an area over which fellings had passed previously as many as 720 Hollong, 548 Nahor and 648 Sam (*Artocarpus Chaplasha*) were found in a 1-acre sample plot.

In this locality "Atlas" compound has been found very effective in killing girdled trees when painted on the girdles during June.

In the Sibsagar Division interesting results are being obtained on the experimental fellings in the Nambor reserve where the principal species are Bonsum and Hollock, both of them being in great demand by timber traders. Hollock occurs almost pure over extensive areas in the Sadiya frontier tract and it forms a nearly even-aged over-mature forest in which there is practically no natural regeneration. So Mr. Adhikari's experiments will probably prove very useful as soon as the lessees commence felling. In the 1-acre experimental plot I of Nambor about 30 trees, principally Bonsum, have been left to an acre, all undergrowth cleaned, advance growth helped and the area burnt over in April. The progress of natural regeneration under this treatment is being watched very carefully and no artificial work has been done. In plot II of the same reserve the principal species are Nahor (*Mesua ferrea*), Amari (*Amoora Wallichii* and *Dysoxylum procium*), Bhelu (*Tetrameles nudiflora*). Nahor is the evergreen shade bearer *par excellence* forming a forest in which all girth classes are represented and which is free of climbers and undergrowth. It is, however, readily damaged by fire. Amari and Bhelu have quite opposite characteristics and cleanings and controlled fire are useful aids to their increase. The timber of Nahor is so hard, gritty, and heavy that large sizes are not of much commercial value although it is valuable for posts, piles, and pit props.

A detailed study of the early stages of the artificial regeneration of various deciduous and evergreen species was also commenced in Sibsagar during the year.

BURMA.

Regeneration.—No details of the concentrated regeneration in Tharawaddy and Toungoo are given in the Conservator's report, but he quotes certain points in connection with teak *taungya* work to which the Divisional Forest Officers of Katha and Myitkyina draw attention. They are—

- (a) The absolute necessity for the careful collection of good seed (the inference being that this is too frequently ignored and plantations fail accordingly).
- (b) Burying the seed for a year in localities where white-ants abound. These insects devour the corky pericarp, and germination is expedited thereby in a very remarkable manner, so that seedlings attain a height of 1' to 3' by the end of the first rains.
- (c) If, during the first season, growth is unsatisfactory, seedlings should be cut back and weeds burnt during the succeeding hot weather.
- (d) Young teak up to three years old damaged by the extraction of timber, if cut back, will produce shoots in a year as tall as seedling teak three years old.
- (e) If a plantation fails, the best thing is to try a second field crop, preferably sessamum, and re-sow the area. If it fails a second time, write it off.
- (f) General experiments are in progress as regards spacing, dibbling, early burning, and suitable species to mix with the teak. *Gmelina arborea*, *Cedrela* sp., *Morus laevigata*, *Michelia Champaca*, *Cassia fistula*, *Bursera serrata*, *Pentacme suavis* and *Dipterocarpus turbinatus* are under investigation as suitable species.

A very important silvicultural phenomenon is the flowering of *Bambusa polymorpha* which is believed to have begun in earnest in certain Divisions of the Pegu Yomas. With a view to this flowering a large number of experimental gaps were made in the bamboo canopy in 1918-19 in several of those Divisions but the results have not been reported except from Shwegyin Division. There except where supplemented by broadcast sowings, the natural regeneration is disappointingly little; as however the prevalent bamboo in the area is reported to be *Oxytenanthera albociliata* this is not to be wondered at.

Experiments made in Shwegyin with the seed of *Kanyinpyu* (*Dipterocarpus alatus*) showed that if the seed were buried for $\frac{1}{3}$ of their length in the ground, apex downwards and stalk end up, they germinated freely, and the radicle went straight into the ground: in a reversed position germination took $2\frac{1}{2}$ months. Wings should be removed, as if left attached the seeds are easily moved by wind and rain. Mr. Hopwood continues, "My own experiments in Tenasserim entirely support these ideas. There can be no doubt that *Dipterocarp* seed must be sown as soon as practicable after it falls (Mr. Cubitt arrived at the same conclusion in the Malay States) and Mr. Thomson's method of sowing appears to promise the best results. The storage of *Dipterocarp* seeds or even their transport for long distance appears inadvisable."

In the Meiktila Division in accordance with the scheme for increasing the available quantity of *Cassia auriculata* for tannin bark, plantations aggregating 417 acres were made at a cost of Rs. 1,050. The experiment proved a failure and has been abandoned; the failure is attributed to caterpillar attacks (perhaps a species of *Catopsilia*) followed by drought. Where it occurs naturally the plant is hard to eradicate. For other remarks regarding the propagation of this important plant see next page. A careful investigation into the best method of propagation may yield better results than have been obtained in Meiktila.

Publications.—Two works of importance were compiled during the year: (1) "Observations on the Germination and Behaviour of Free Seedlings with special reference to *taungya* plantations" by H. R. Blanford, O.B.E.; (2) "A Handbook of Forest Products of Burma" by A. Rodger, O.B.E. The first was published and the second is still in the press. A note on the Nilambur Teak plantations written by Mr. Rodger mainly from the Burma point of view was also published.

CENTRAL PROVINCES.

There are no officers on special duty in the Central Provinces. Hence, although a good many investigations of the type necessary for the forests of the Province have been begun or carried on, there cannot be the same homogeneity and continuity in them as result from the inquiries of officers on special duty. It appears from the report that the Conservators' conference of 1919 decided the work to be done and that its instructions were carried out by certain of the Divisional Forest Officers.

Rates of Growth.—In the Jubbulpore Division sample plots were opened with a view to ascertaining the suitability of a rotation of 30 years for coppice. The species selected for measurement were teak, *Terminalia tomentosa*, *Lagerstræmia parviflora*, *Anogeissus latifolia*, *Ougeinia dalbergioides*, and others which are fairly common, or in demand. The record deals with single measurements, apparently of the largest shoots in the best clumps, and secondly with repeated annual measurements and the present conclusion is that the girth growth is unexpectedly slow. A similar experiment is in hand in South Raipur. In the latter Division also two sample plots for the girth increment of sal are kept up.

Regeneration and Progress of the forest crop.—In South Raipur there are also certain plots to trace the establishment and development of sal seedlings and again the effect in the latter of removing the ground cover over the latter and lightening the canopy. No conclusions can be drawn as yet from these plots.

In the Melghat silvicultural research work is confined to teak, namely the study of (1) the effects of light and shade on the growth of teak seedlings whether propagated artificially or naturally; (2) the cheapest and most successful method of regenerating the species; (3) the rate of growth of teak in plantations and in natural mixed forest. The first and second are still being carried out while the conclusions arrived at by the Divisional Forest Officer (Mr. Best) regarding the third have been published in the "Indian Forester," Vol. XLVI, No. 4. The Melghat has about a thousand acres of teak plantations which were formed in clear-felled areas, between 1868 and 1879 under the supervision of Mr. Ballantyne but they have not received regular attention. Mr. Best's measurements go to show that teak plantations formed in frost-free localities in the Melghat and thereafter moderately thinned show a good profit, but those made in places effected by slight frost only pay if thinned, while those in bad frost areas do not pay under any circumstances.

Experimental sowings of *Cassia auriculata* were made both in the Jubbulpore and Hoshangabad Divisions. In the first, $3\frac{1}{2}$ seers an acre were sown over an area of 31 acres and of the results the Divisional Forest Officer writes: "The areas selected in some cases were not suitable; otherwise germination was good. It has been found that light sandy soils are most suited to the species, preferably on a gentle slope.

at the foot of a hill. The species is hardy and though frost killed the leaders last cold weather in some of the plots it has by no means killed the seedlings which have thrown out new shoots in 75 % of the plants. I have not found grazing do any harm either ; the leaves are not eaten by cattle but grass is kept down and a service done." In Hoshangabad the ground was cleared of tree growth and the soil thoroughly broken up by plough and harrow or by hoe; one seer of seed was sown to an acre in one area in the 2nd week of August and in a second area in the last week of July. Germination failed completely in water-logged places, was partially successful on black cotton soil and successful on well-drained red soil.

MADRAS.

Programme of Research.—The programme for the newly appointed Forest Research Officer in Madras lays down the study of the silviculture of the deciduous semi-evergreen and evergreen forests of the West Coast with a view to (1) the regeneration of the most valuable commercial species in the most economical manner, and (2) the subsequent treatment of the crop in accordance with the silvicultural requirements of the several species. His attention is confined to 10 named deciduous and 11 named evergreen species and the forests which they form in three localities, namely the Chenai Nair reserved forest on the slope of the Ghats, the teak plantations and natural forest of the Nilambur valley and the *Hopea* forest of South Kanara.

Organisation.—Notes collected during the year were ledgered. The building up of an executive and clerical staff and other work necessary to make this forest research a self-contained unit received attention during the year.

Regeneration.—A nursery was formed at Dhoni, and the nursery experiments during the year dealt specially with *Hopea parviflora* and *Artocarpus hirsuta*. In addition, 10 half-acre plots were laid out for studying the effect of varying degrees of shade on the germination of the seed and the growth of the seedlings of the same two species, with which it is planned to try the underplanting of teak both in Nilambur and elsewhere. From the observations made so far, it appears—

- (1) that seeds of *Artocarpus hirsuta* are capable of retaining their germinating power for a longer time than those of *Hopea parviflora* (a Dipterocarp);



Photo-Mech. Dept. Thomason College, Roorkee.

Photo by T. B. G. Sutrakar.

Lampati (*Duabanga sonneratioides*) plantation in Bengal, 9½ years old at about 1000 feet.
Largest tree, 3 feet 4 inches in girth.

- (2) that seeds of *Hopea parviflora* of good quality collected straight away from trees and not picked off the ground after they have fallen naturally are capable of retaining their germinating power for at least a fortnight from the date of collection if they are preserved carefully from damp;
- (3) that the percentage of successful germination of *Hopea* is greater if the seeds are dibbled in prepared patches under light shade than when sown in seed beds fully exposed to the sun;
- (4) that the seeds of *Hopea* should not be covered with more than a very thin layer of soil and they should be sown with their wings lying horizontally in the beds; and
- (5) that the removal of the pericarp does not effect the germination of the seed.

Further observations however are required before any definite conclusions can be drawn.

Seven other half-acre experimental plots were laid out before the close of the year with a view to the raising of pure crops of *Bombay malabaricum*, *Tetrameles nudiflora*, *Terminalia paniculata*, and *Gmelina arborea* as timber for boxes and crates.

CHAPTER III. FOREST BOTANY. CENTRAL INSTITUTE.

Ecology of Sal and Soil Aeration.—The result of the investigations of past years will appear shortly as a Forest Record. Further investigations are in progress at Dehra Dun. Owing to the pooriness of last year's seed crop the work was considerably hampered, but this year a better crop was obtained and all the necessary sowings have been completed.

Forest Grasses.—Experiments on the cropping of Ulla grass (*Anthistiria gigantea*) for paper pulp were continued on the previous lines in the Pilibhit Division of the United Provinces.

Spike Disease of Sandal and Zizyphus.—Inoculation experiments are being continued in Dehra Dun and investigations continue in Madras and Coorg.

Mycology.—The root diseases of sal and sissoo, *Polyporus shorea* and *Fomes lucidus*, are being studied and investigations into the cause of "redwood" in Spruce have been commenced.

Systematic.—Large numbers of specimens were received from Forest Officers for identification chiefly in connection with the preparation of descriptive lists and local floras. During the year 131 specimens were identified here. The work has incidentally brought to light species of the following genera which are probably new and descriptions of which will be published when verified: *Berberis*, *Cordalis*, *Diospyros* and *Hopea*.

Publications.—During the year the following publications appeared:—

Gupta, B. L.—New Indian Species of Forest Importance, "Indian Forester," Vol. XLV, pp. 388—392.

Hafiz Khan, A.—Red Wood of Himalayan Spruce (*Picea Morinda*, Link) loc. cit., pp. 496—498.

Herbarium.—1,003 sheets were added to the herbarium during the year, the principal contributors being Messrs. A. E. Osmaston, R. N. Parker, C. G. Rogers, B. L. Gupta, H. Tireman and P. J. Draper.

Library.—12 volumes exclusive of periodicals were added at a cost of Rs. 105 and 20 were added by donation.

Tours.—No tours were made as Mr. R. S. Hole, Forest Botanist, was on leave during the whole of the year.

Indents.—A large number of indents for seeds were complied with and they were despatched to various places in India, and to Natal, Uganda, the Soudan, Abyssinia and Egypt, Cape Verde, New South Wales, Chili and the United States of America.

UNITED PROVINCES.

Mycology.—The fungus *Peridermium corticola* has long been causing serious trouble in the plantations of *Pinus longifolia* near Almora. Research on the subject is in hand but no results are available for publication yet.

BENGAL.

Mycology.—In the Inspector-General's note of his tour of inspection in Bengal and Assam, to which reference has been made already, he discusses a matter of grave import to all officers concerned with the administration of sal forests, namely the mortality of sal and the part which the root fungus *Polyporus shoreæ* (Wake) has in it. The manufacture of dry timber, especially sal timber, by forest-workers is undoubtedly a common malpractice in the Sub-Himalayan forests and very damaging to the canopy. In the eight years ending 1912-13 the average outturn of dry sal from the Buxa forests amounted to the large total of 6,23,098 cubic feet. Though the figures were held to be inaccurate the system of exploitation was changed to one of extraction on a six years' rotation, the trees being marked before felling and sold by auction. The large outturn under the old system was considered by the local officers to be due to creepers, insects and unknown causes and the Forest Zoologist was called on to inquire into the possible causes of death by insects. Mr. Beeson came to the conclusion that insects were only of secondary importance and it was while he was engaged, on the investigation that he discovered the root fungus. The average outturn of dry sal timber during the past six years is 1,30,844 cubic feet which the Divisional Forest Officer (Mr. Glasson) considers is derived from a normal and natural annual

Development Department, the idea being to start a centre for sericulture at Maymyo. The Development Commissioner has been definitely promised that the garden can now guarantee to raise mulberry plants sufficient to stock a plantation for feeding the silk-worms.

The expenditure incurred on the garden in 1919-20 was Rs. 15,793.

Herbarium.—During the year 1,200 botanical specimens were received for the herbarium, many of which still await identification. Of those identified perhaps the most important from an economic point of view are the Yemanés of Mergui which proved so useful for box making and turn out to be two species of *Lophopetalum* (*fimbriatum* and *filiforme*) and not *Gmelina*. By far the largest collections are those sent in by Mr. C. G. Rogers, lately Chief Conservator; these were obtained by him in South Tenasserim, the dry zone and Katha.

CHAPTER IV.

FOREST ECONOMY.

CENTRAL INSTITUTE.

The feature of the year's work has been the deputation in August 1919 of the Forest Economist, Mr. R. S. Pearson, to America and England with the object of reporting on the organisation of forest research in the former country and of purchasing plant consisting of timber testing machines, seasoning plant, a saw-mill and other modern fittings for the Economic Section of the Research Institute. With a similar object Mr. Raitt, Cellulose Expert, proceeded to England in October 1919 with a view to purchasing an experimental pulp and paper making plant. During the year under report therefore the work of the branch has consisted mainly in the purchase of new plant and fittings for the proposed extension of the Institute and work at Dehra has been practically limited to the routine work of replying to enquiries regarding sources, outturn and prices of forest products. Field work has similarly been limited to an examination of the markets for turpentine and rosin throughout India, inspection of the timber seasoning experiments in South India and an investigation regarding possible developments of the trade and the outturn and prices of timber in South India and the Andamans.

Observation and Encouragement of the Paper Pulp Industry in India and Burma :—During October 1919 Mr. Raitt proceeded on leave to England with the object of purchasing the requisite experimental pulp and paper making plant for the new workshops. With the erection of these plants it will be possible to carry out exhaustive experiments on the various kinds of bamboos, grasses, and other raw materials which exist in India and Burma and which now await the results of such experiments for their development.

The question of utilising bamboo and large grasses for the manufacture of paper pulp has been under investigation for a long time at this Institute and had it not been for the great war there can be no doubt that the bamboo pulp industry would have been started ere this. Now that it is again possible to obtain machinery, definite steps have

been taken to erect pulp mills in India. Thus, one mill is nearly complete near Calcutta and should be in a position to start work early in 1921, obtaining its bamboos from the Chittagong Hill Tracts; another is to be erected in Burma obtaining its bamboos from the Pegu Division, while a third scheme is contemplated in Tavoy. Bamboo pulp is actually being manufactured at present in Cochin State and also in Burma, though not on a large scale. The question of utilising Elephant grasses for paper pulp requires much further enquiry which cannot be carried out until the experimental pulp and paper machines are erected.

Antiseptic Treatment of Timber:—The experimental creosoting plant was received from England during the year and is being erected. A fresh supply of 350 green sleepers of Spruce and Silver Fir has been obtained from the Punjab for the conduct of the first series of experiments and steps are now being taken to purchase an electric motor to facilitate the working of the plant.

The experiments with sleepers of five species of timber treated by the Powell process, with chloride of zinc and oil, with Avenarius Carbolineum and with mixed creosote and Earth oil, which were laid down in the open lines, commencing in 1911, have been reported on during the year and are doing well. The results of these experiments have induced various railway companies to take a greater interest in the question, and two companies are contemplating the erection of plants to treat conifer and other timbers. The question of starting this business is largely bound up in the question of cost. Efforts have been made all over the world to reduce the cost, due to the rise in price of creosote. A method advocated was to treat sleepers first with chloride of zinc and then, in order to prevent the salt being washed out of the timber, to immerse the sleepers in oil; this was tried in India, but with only partial success. A process has now been evolved in America, known as the Card process, by which the salt and oil are introduced simultaneously, which is claimed to give most satisfactory results. The Forest Economist visited, while in America, an installation working according to this system, and it is thought that it would be quite applicable to Indian conditions and may solve one of the difficulties of introducing treated sleepers into this country.

Physical and Mechanical Properties and Seasoning Powers of various Timbers :—

(i) *Natural Seasoning.*

An initial experiment was started on a small scale in 1914, in nearly all provinces of India, to season various timbers by natural methods. These experiments were completed in 1918, and gave such promising results that it was decided to extend the scope of the enquiry after the results of the first enquiry were available and recorded in Indian Forest Records, Volume VII, Part I of 1919.

These detailed seasoning experiments were initiated last year at various centres in the Punjab, United Provinces, Assam, Bengal, Bihar and Orissa, the Central Provinces, Coorg and Madras, the records for which have been compiled, examined and put in order while the experiments were inspected in detail at two centres in Madras. These experiments now await the final inspection during the coming season.

(ii) *Artificial Seasoning.*

This subject has been studied in detail by Mr. Pearson while on deputation in America and England with the result that the standard American and English experimental seasoning plants, *vis.*, a 3-chambered Tiemann and a 4-chambered Sturtevant plant, have been purchased and are expected shortly in India.

(iii) *Mechanical Properties of Timber.*

It having been for long realised that the present timber testing machine in the Economist's workshop is quite inadequate, three of the latest standard pattern machines have been purchased in America and two others in England and all these are now on their way to the Research Institute.

Detailed mechanical tests on *Eucalyptus Globulus* and *Acacia melanoxylon* from the Nilgiris and *Olea ferruginea* from the Punjab have been carried out during the year.

In view, however, of the purchase of the new machines, tests on the old machine have been suspended and timber from eleven other species has been received and is now laid down to season pending the arrival of the new plant.

Finding of Markets and new uses for Timbers, including the Issue of Bulletins:—Bulletins on the following timbers were completed during the year and are now in the press:—

1. *Bombax malabaricum*.
2. *Adina cordifolia*.
3. *Odina Wodier*.
- *4. *Lagerstræmia Flos-Reginæ*.
- †5. *Dipterocarpus pilosus*, while that on
6. *Hopea odorata* is still under compilation in Burma.

The number of enquiries from firms and others on the subject not only of the utilisation of Indian timbers for special purposes but also of the sources and available supplies of such timbers indicate the extreme importance of this head of research, and the necessity for the collection of reliable data regarding local outturn and prices.

Probably the greatest stimulus which has been given to Indian timbers in Europe during recent years is an exhibition of Indian, Andaman and Burmese timbers at the Empire Forest Exhibition, which was held in July 1920 in London. The exhibits consisted of a complete double staircase, one side made of Andaman Padauk, the other of *Terminalia bialata*, and in front parqueting of these timbers and *Dipterocarpus turbinatus*. Several rooms were panelled with a variety of timbers such as *Albizia Lebbek*, *Terminalia tomentosa*, *Dalbergia Sissoo*, with suites of furniture inlaid with Walnut to match. A large variety of articles, such as golf clubs, walking sticks, turnery work, carving, boot-trees, and parqueting work, made of Indian timbers, was also exhibited. This fine exhibit, which was arranged by Professor Troup, C.I.E., and Mr. Alexander Howard of Messrs. Howard Brothers, was the centre of much interest and resulted in numerous enquiries being made for Indian timbers.

Gums, Resins and Oil-resins:—The possibilities of an industry based on the tapping of Salai (*Boswellia serrata*) for its gum-oleo-resin as a source of turpentine continues to attract considerable attention. Bulk samples obtained from Khândesh were examined at the Indian Institute of Science, Bangalore, and samples of products have been

forwarded to an interested Bombay firm for transmission to London for valuation. Tapping operations commenced in Khandesh and the Gwalior and Kotah States, are now being extended to Bhopal and further developments depend upon the erection of a distillery at some suitable centre.

Rosha Grass Oil:—The object of improved methods of distillation continues to elicit numerous enquiries. The question is being investigated on a commercial scale in the Central Provinces and Bombay and it is understood that the possibility of increasing the outturn of grass in the Central Provinces is a question which is now engaging the attention of the local officers.

Wood Suitable for:—(i) Wood paving Blocks.—This subject is under observation in Bombay and the experimental pavements of Xylia blocks have been considerably extended.

(ii) Bobbins, Shuttles and Picking sticks for Cotton and Jute Mills.—Experiments on a commercial scale on various Indian timbers are now being undertaken by the Utilisation Circle of the United Provinces. The leading firm of bobbin manufacturers in England has been approached with a view to starting a branch business in India.

(iii) Rifle Stocks.—Since it has been found impossible to find any really suitable substitute for walnut timber, operations are now being concentrated on the supplies of properly kiln-dried walnut half wroughts to the Ishapore Rifle Factory from the N.-W. Frontier Province and from Kashmir.

(iv) Three-ply.—The manufacture of three-ply has now passed beyond the experimental stage in Assam where ply boxes for tea are now being manufactured from a wide variety of timber species. Difficulties have, however, lately been encountered in the matter of a tendency to 'cheesiness' in certain timbers, such as *Endospermum chinense* and *Tetrameles nudiflora*, when used for this purpose. This matter is one of vital importance to the industry and the possible solution of the difficulty is now being made a subject for detailed investigation. The possibilities of three-ply for tea and rubber boxes are also being considered by several firms in South India as it is now becoming increasingly difficult to obtain adequate supplies of

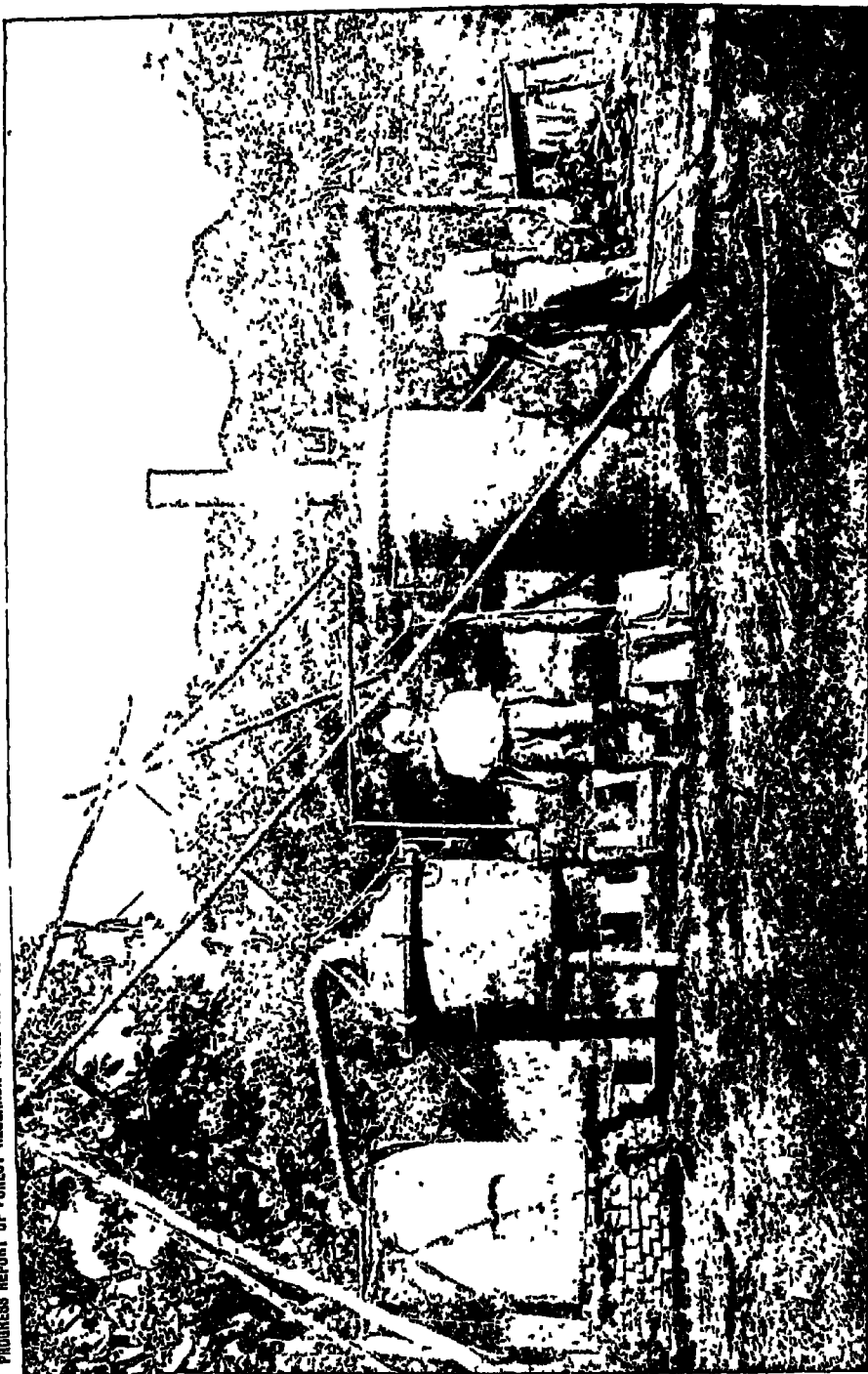


Photo-Mech. Dept., Thomson College, Roorkee.

Experimental Steam Distillation Plant working Rosha grass, Chikhalde, Malsat Division, Central Provinces.

Photo by T. S. Pearson.

suitable timbers at a price which will permit of the ordinary box industry being run at a profit.

(v) *Cooperage*.—The general question is being investigated on a semi-commercial scale by the Utilisation Circle, Bareilly. The problem of finding a suitable timber or timbers for cocoanut oil casks in South India in addition to White Cedar (*Dysoxylum* spp.), which is the only timber now being used for the purpose, remains to be solved. The subject was opened by Messrs. Tata's Limited, who have erected a large oil mill at Ernakulam and intend to use imported Douglas Fir for the manufacture of oil casks, it being considered that this procedure is likely to prove more economical and satisfactory than that of depending upon a supply of the locally made casks. On the analogy that Douglas Fir has been found suitable for the purpose in the Philippines and elsewhere sample casks and shooks of the chief Himalayan conifers have been supplied by the Utilisation Circle, Bareilly, to the Tata Oil Mills, Ernakulam, for testing and four casks have also been sent to this branch in Dehra.

Steps have also been taken to purchase an experimental stave cutting and barrel making plant for the Economic workshops of the Research Institute so that there is every hope that a solution to the problem of a suitable timber for oil casks will be found reasonably soon.

Charcoal Briquettes.—An experimental briquetting press was purchased and erected during the year and the first series of experiments on charcoal dust with a binder of *Bauhinia retusa* gum have been carried out. The problem of an entirely suitable binding medium is as yet unsolved but valuable data on this subject have been collected during the Economist's tour in America which may be expected to indicate new lines for investigation.

A serious difficulty which was represented to the Forest Economist in America was the question of grinding charcoal to a fine dust preparatory to pressing it into briquettes. It appears that it is extremely dangerous to grind charcoal as it is liable to explode, and it was stated on good authority in Chicago, where ground charcoal is in great demand, that they write down their machinery at one year's life. To overcome this trouble the Madison Forest Products Laboratory are carrying out experiments in which they press up sawdust into briquettes and then carbonise them under pressure.

Other Enquiries :—Miscellaneous enquiries from firms and individuals, private and official, continue to increase in number and variety of subject, a sure proof of the need for special officers to deal with the various subjects. Such a need has been realised for a long time and steps have now been taken for the recruitment from America and Canada of specialists in timber technology and seasoning.

A number of interesting additions were made to both the Timber and Economic museums during the year.

UNITED PROVINCES.

Apart from what is mentioned in the Central Institute report concerning the work of these Provinces, the following details deserve notice. All the work has been done at Bareilly except the chir tar distillation.

Experimental.—A great deal of valuable pioneer work was done by the United Provinces Wood Technologist (Mr. Kinns) which included the investigation of the best methods of conversion and the most suitable timbers for implements, containers and articles of various other economic kinds.

Seasoning.—Owing to the delay in the arrival of various instruments from the United States of America the seasoning kiln which is a two battery Tiemann kiln of the water spray type, thermostatically regulated, did not commence its career of usefulness during 1919-20. The problems to be dealt with are numerous and will necessitate long and careful study but the ultimate results from the experiments of this and similar plants will have a far reaching effect on the timber trade of India.

New Markets and Uses.—At present investigations are being concentrated on *Pinus longifolia*, *Picea Morinda*, and *Abies Pindrow*. The necessity for obtaining new markets for these has long been appreciated and the results obtained show the possibilities of future development. Interior wood-work for buildings such as match boarding, cornice moulding, door and window bars, is being made from these timbers with good results. They are also being tried by one of the railway companies in the construction of railway carriages. It is hoped that in future they will replace the large quantities of

imported deal and fir which meanwhile command a ready sale on the Indian markets.

A plant for the manufacture of wood-wool has been laid down and it is proposed to utilise small sawn ends and wood waste for this purpose. The product is used for packing china and glassware. The price obtained for imported wood-wool before the war was 12 annas per pound.

A wood bending machine is also being laid down and it is intended to test the suitability of various timbers for the manufacture of felloes for carts and carriage wheels. The steaming and bending of blanks from small Shisham poles for the manufacture of spade-handles finds a ready use for what has hitherto been unmarketable timber in the United Provinces. Other small articles for which local timbers have been tried successfully during the year are picking sticks for calico looms and laggings for jute mill rollers, golf and hockey sticks, boot-trees, railway keys, cutter blocks.

Gums, Resins and Olco-resins.—Experimental work in chir-tar distillation was continued in the West Almora Division of the Kumaon Circle. The old plant was dismantled and in its place two batteries of the new retorts, each of two units or double retorts, have been erected at the old site and one on a new site a few miles distant. The distillation was not well done and the yields reported are disappointingly low. The reason is that it was not possible to arrange for the same skilled supervision as last year and in an infant industry this makes the difference between success and failure.

Woods suitable for Various Purposes.—For hobbins eight timbers have been tried of the more valuable miscellaneous species of the Bhabar and plains forests. The best results have been obtained from *Adina cordifolia* and *Holoptelca integrifolia*. For handles of various patterns the timbers used are *Terminalia tomentosa*, *Anogeissus latifolia* and *Dalbergia Sissoo*. There is now a good demand for these handles. Half a dozen timbers have been tried in casks. Chir (*Pinus longifolia*) is used in large quantities for slack casks but for the fuller investigation into the possibilities of tight cooperage the advent of an expert cooper is awaited. In the manufacture of brushes the wood of ash (*Fraxinus floribunda*), holly (*Ilex dipyrrena*) and *Adina cordifolia* are very favourably reported on, by brush-making firms.

BIHAR AND ORISSA.

Seasoning of Timber.—A considerable number of seasoning experiments are in hand in accordance with the suggestions of the Forest Economist; the species under trial are *Soymida febrifuga*, *Eugenia Jambolana*, *Odina Wodier*, *Anogeissus acuminata* and *Boswellia serrata*.

Experiments are also in hand to ascertain the best type of kiln to produce first class charcoal in an economical manner but are not sufficiently advanced to furnish useful information.

BURMA.

Museum.—The collections, mainly economic, in the forest museum at Rangoon were considerably added to and improved. They attract an ever increasing number of visitors, many of whom are actuated by motives other than mere curiosity and whose visits lead to inquiries for commercial products.

General Development.—In general, the year was spent as at the Central Institute in making plans for the future. The experimental seasoning plant at Insein was closed in view of the impending arrival of the dry kiln now *en route* from America which is to be erected at the Government Dépôt, Rangoon. Plans for portable saw-mills are also under way, as well as for the erection of a workshop and laboratory for timber research, and for the building of dry kilns and testing machines and putting up a small saw-mill plant, for veneer cutting and making plywood barrels, articles of turnery, and shingles, for all of which there should be a great scope among the numerous little-known timbers of Burma.

CENTRAL PROVINCES.

Seasoning of Timber.—In common with other provinces further seasoning experiments are in hand in accordance with instructions received from Dehra Dun. They were started at Allapilli in 1918-19 and will be completed in 1920-21. Ten species are being dealt with, including *Chloroxylon Swietenia*, *Grewia tiliaefolia*, *Anogeissus latifolia*, *Soymida febrifuga*, *Hardwickia binata*.

Suitability of Timbers.—From the same Division (South Chanda) timber of *Saccopetalum tomentosum* is being supplied to a Bombay firm to test its suitability for billiard cues as a substitute for ash (*Fraxinus floribunda*).

BOMBAY.

Fibres.—Large samples of the fibre of the Talipot palm (*Corypha umbraculifera*) were sent, among others, to the Fibre Expert to the Government of Bengal and to interested firms from the South Kanara Division. Though somewhat brittle the fibre is of extraordinary length and tensile strength and might be very useful for cordage of good quality when prepared with the proper oils.

CHAPTER V. FOREST ZOOLOGY.

CENTRAL INSTITUTE.

The following items of the sanctioned programme were dealt with:—

Insects of the Sal.—Borers. (a) *Field work.*—Observations were continued in the two permanent incidence plots established in the borer-attacked parts of Thano forest, Dehra Dun, and a third plot of 60 acres in the peripheral zone was surveyed and enumerated. Analyses of trees showing different degrees of attack were made to determine (a) the number of successful emergencies, the proportion of failures due to parasitism, disease, etc., and (b) the conditions governing the survival of slightly attacked trees. Control measures devised in 1918, involving the removal of borer infested trees within the year of attack, were tested over about 250 acres, in which area no subsequent damage has occurred.

To determine the seasonal succession of sal borers and its connection with felling dates, an experiment has been started in which 12 sal trees are felled, one in each month throughout the year, and from each tree a log is removed monthly and caged.

(b) *Insectary work.*—Experimental rearing of larvæ from the pre-pupal stage in sealed tubes under varying conditions of moisture was continued with the object of determining the mortality due to parasitic fungi, bacteria, and diseases of unknown origin. The fungi were identified by Dr. E. J. Butler, Imperial Mycologist, who isolated a series of species of the genera *Adadium*, *Aspergillus*, *Botrytis*, *Cephalosporium*, *Dendryphium*, *Harpographium*, *Helminthosporium*, *Hormodendron*, *Penicillium*, *Stysanus*, (*Melanospora*) and *Verticillium*. The mixed nature of the fungus flora (which contains hyperparasites) and the variation in the morbid symptoms indicate that several factors cause the death of *Hoplocerambyx spinicornis* larvæ and that the prevalence of a specific parasitic fungus is less probable than was supposed.

Other pests.—Insectary records have been obtained of pests of sal seed and the young seedling. The species primarily concerned are *Dichochrosis leptalis*, *Laspeyresia pulverula* and *Calandra* sp.

Insects of the Teak.—An illustrated note on the Bechhole Borer of teak, with suggestions for its control, has been prepared, and is now in the press as a Forest Record. No field work was carried out by the Forest Zoologist's staff, but observations are being continued in sample plot areas by divisional officers.

Insects of the Toon.—The chalcidoid parasites of *Hypsipyla robusta* have been described by Captain the Revd. Waterston, Bureau of Entomology, in a paper that will shortly appear as a Forest Record. Work has been started on the biology of the hymenopterous parasites and the predators of the caterpillars of this borer.

Lac.—A microscopic examination of the internal morphology of lac insects was carried out under the direction of the late Mr. F. M. Howlett, with the object of discriminating specific differences in the form of lac insects from different kinds of host trees.

Miscellaneous Pests.—During the year under report 186 consignments of specimens (including 1,362 insects) were received for investigation. In collaboration with the Forest Economist the borer fauna of timbers laid down under different methods of seasoning is being worked out. A total number of 2,614 pieces of timbers laid down under different methods of seasoning is being worked out. A total number of 2,614 pieces of timber has been received from divisions in which seasoning experiments are in progress and from this material, numerous species of borers (amounting to some 7,000 specimens) have been bred out, adding considerably to our information on the food trees and distribution of timber pests. The more important of the new records are :—*Aeolesthes holosericea*, Fab. ex *Drimycarpus racemosus*; *Batocera tilana*, Th. ex *Sterculia villosa*; *Ceresium leucosticticum*, White ex *Anogeissus latifolia* and *Grewia tiliaefolia*; *Coptops edificator*, ex *Aegle Marmelos*, *Careya arborea* and *Holoptelea integrifolia*; *Dialeges pauper*, ex *Cassia fistula*; *Diorthu cinereus*, Fab. ex *Hardwickia binata*; *Epipedocera affinis*, Chev. ex *Grewia tiliaefolia*; *Gnatholea simplex*, Gah. ex *Hardwickia binata*; *Margeles modicus*, Gah. ex *Anogeissus acuminata* and *Anogeissus latifolia*; *Nyphasia apicallis*, Gah. ex *Anogeissus acuminata*; *Plocaderus ferrugineus*, Linne ex *Boswellia serrata*, and *Hardwickia binata*; *Xylotrechus quadripes*, Chev. ex *Hymenodictyum excelsum*; *Xylotrechus renominatus*, Beeson ex *Shorea robusta* and *Amoora Rohituka*; *Xylotrechus smeii*, L. et G. ex *Careya arborea*; *Xystrocera globosa*, Oliv. ex *Acacia modesta*; *Platypus solidus*, Wat. ex *Acrocarpus fraxinifolia*.

Insect collections.—Small batches of insects have been identified and returned by the following specialists :—

Siricidae and *Tenthredinidae* by Dr. S. A. Rohwer; *Syrphidae*, *Stratiomyidae* and other *Diptera* by Mr. E. Brunetti; *Asilidae* by Miss G. Richardo; *Odonata* by Major Fraser; *Aphidae* by the Government Entomologist, Madras; *Microlepidoptera* by Mr. E. Meyrick; *Carabidae* by Mr. H. E. Andrews; *Bostrychidae* by Mr. M. P. Lesne; *Tenebrionidae* by Mr. K. Blair; *Lamellicornia* by Mr. G. Arrow; *Curculionidae* by Dr. G. Marshall; *Scolytidae* and *Platypodidae* by Col. Winn-Sampson; *Cerambycidae* and *Lamiidae* by Dr. G. Gahan. While on leave the Forest Zoologist visited specialists in England and France and distributed 5,000 specimens of *Coleoptera* and *Hymenoptera*.

Museum.—The principal additions to the museum comprise 529 specimens of timber showing the work of borers, skins of palm squirrels, bats, bamboo-rats, etc. A consignment of 86 specimens of damage by borers to the principal Indian forest trees was presented to the School of Forestry, Oxford.

Staff.—Consequent on the sanction by the Secretary of State for the recruitment of four forest entomologists arrangements were made for the post-graduate training of certain I.F.S. probationers in entomology. The new post of Systematic Entomologist has been filled by the appointment of Surgeon Commander M. Cameron, M.B., R.N.

Mr. Beeson was deputed to attend the Imperial Conference of Entomology held in London, June 1920, as the representative of the Government of India.

Zoologist's Library.—105 new books in addition to periodicals were added.

Tours.—No tour was made during the year except by a field party which was more or less continuously in the Thano forest, Dehra Dun Division, United Provinces, chiefly in connection with the *Hoplocerambyx* epidemic.

BURMA.

Insects of the Teak.—There is nothing definite to report about the study of the beehole borer (*Duomitus ceramicus*). At the suggestion of Mr. Mackenzie a number of nesting boxes were put up in teak plantations in the Prome Division with the view of inducing insect-eating birds to make their nests in them. As the eggs of *D. ceramicus* are

laid on the bark of teak and as two of the most persistent insect-hunters, the nuthatch and the grey tit, nest readily in suitable boxes the experiment is one well worth trying.

Another point already under investigation and which appears to deserve very close and careful attention is the influence which fire has on the prevalence of this borer. The evidence on this point so far is very conflicting in some cases appearing to lead to the conclusion that fire destroys the insect in one or more of its metamorphoses, in others that it directly assists the pest.

CHAPTER VI. FOREST CHEMISTRY.

CENTRAL INSTITUTE.

Research work was resumed with the advent of Dr. J. L. Simonsen to fill the vacancy caused by the absence of Mr. Puran Singh on leave. The latter has since gone on a medical pension.

Gums, Resins, Oleo-resins and essential Oils.—Work has been done on the following trees, shrubs and products.

Skimmia Laurcola.—The leaves of this evergreen under-shrub have been distilled and the essential oil isolated. The results of an examination of the oil are approaching completion.

Note.—The shrub is common in the Oak and Fir forests throughout the Himalayas and frequently interferes with the regeneration of trees of valuable species. If a regular supply of the oil can be made at the most productive season the product might well have a considerable market value.

Zanthoxylum alatum.—The seeds have been distilled and the oil is under examination.

Camphor and Camphor Oil.—The results obtained in past years have been subject to analysis and it has been found that the leaves of coppiced trees yield about 4 per cent of camphor and camphor oil. Further experiments are being made to determine the acreage yield of camphor and camphor oil. The oil from the leaves after the removal of the camphor is likely to be of little value since it contains no Saftrol. A detailed investigation of the constituents of the oil from the leaves, twigs and wood has been made and the results will shortly be published.

Indian Turpentine.—A detailed study of the turpentines obtained by the steam distillation of the oleo-resin from the various species of *Pinus* occurring in India has been commenced.

The oil from *Pinus longifolia* has been examined and has been shown to consist of α -pinene, β -pinene, d -carene and d -longifolene.

Two of these terpenes, d -carene and d -longifolene, are new. The constitution of d -carene, which is the cause of the ready oxidation of the turpentine from *Pinus longifolia*, has been determined with some

certainly whilst *d*-longifolene has been shown to be a tricyclic terpene. The results of this investigation have been published in the Transactions Ch emical Society, 1920. 117, 570.

The turpentine from the oleo-resin of *Pinus Khasya* from Burma has been examined, a sample of the oleo-resin having been distilled at Jallo for this purpose. Nearly 90 per cent of oil distilled below 170°/700 mm. and consists of a mixture of *d*- α -pinene and β -pinene. The turpentine is of a very high quality and is equal to the American oil. The high boiling fractions contain a sesquiterpene identical with *d*-longifolene present in the oil from *Pinus longifolia*.

Medical Research.—A number of specimens of the flower heads of *Artemisia maritima* have been examined, but no Santonin has been isolated.

Dyes.—The root bark of *Morinda citrifolia* has been shown to contain in addition to morindone, rubiadin, monomethyl ether and alizarine α -methyl ether. Experiments on the synthesis of morindone are in progress.

Miscellaneous inquiries.—As usual a number of analyses of samples submitted by forest officers have been made whilst the usual moisture determinations have been carried out for the Forest Economist.

Publications.—

1. The constituents of Indian Turpentine from *Pinus longifolia*, Roxb. Part I, by J. L. Simonsen (Trans. Chem. Soc., 1920. 117, 569.)
2. Note on the Constituents of *Morinda citrifolia*, by J. L. Simonsen. (Trans. Chem. Soc. 1920. 117, 561).
3. The distillation of Camphor in India, by J. L. Simonsen and T. P. Ghose (in the press).

PUNJAB.

Standardisation of Indian Turpentine from *Pinus longifolia*.—Large quantities of turpentine are now distilled annually from the oleo-resin of *Pinus longifolia*, and attempts have been made to produce a standard turpentine of uniform composition at Jallo, but although progress had been made, a standard turpentine had not been produced prior to an investigation made by the Manager, Captain Guest, during the year. The following description is taken *in extenso* from the latter's report.

The first step in attempting to produce a standard oil is to decide on the standard of oil desired; the second step is to arrange the distillation so as to produce the maximum amount of oil of this standard.

There is a considerable literature on the subject of turpentine specifications, but, from the economic stand-point, as Indian turpentine will have to compete with American turpentine it was decided to accept the specifications recently drawn up by the U. S. Bureau of Chemistry with a view to general adoption in that country. The specifications are detailed below :—

Specification for Turpentine.

			Max.	Min.
Specific gravity @ 15.5°/15.5° C.	...	...	0.8720	0.862
Refractive index 20° C.	...	...	1.478-7	1.468
Initial boiling point at 760 mm. pressure	...	...	160°C.	150°C.
Distilling below 170°C. @ 760 mm. pressure	...	...	...	90%
Colour—"Standard" or better.				
Appearance—Shall be clear and free from suspended matter and water.				

The distillation process consists of a primary distillation to separate the solid residue (rosin) from the liquid distillate. The latter is separated into the bulk oil and inferior oil, each of which is subject to re-distillation in order to separate the quality I oil from that of quality II and III. It was considered that the three physical qualities which could be usefully employed for control tests are :—

(a) Refractive index.

(b) Specific gravity.

(c) Percentage distilling over below 170°C.

(a) Refractive Index is probably the best property to rely on but was ruled out owing to lack of the necessary refractometer.

(b) Specific Gravity at first sight appeared suitable. In general the specific gravity increases with the boiling point of turpentine and eventually a certain specific gravity is reached beyond which the turpentine could not conform to the specifications. Experiments were carried out with a view to finding this maximum gravity, the intention being to procure a ball which would just float at this particular density and put it in the turpentine issuing from the condenser. The ball would rise to the surface when the maximum density allowed was attained and at this point the distillation would be stopped.

Unfortunately for the idea the experiments showed that the variation of density with the boiling point was not regular. It was found that the density decreased to a certain point and then began to increase. There were also other difficulties and so this idea was dropped.

(c) Percentage distilling over below 170°C .

This property was then considered and after a few preliminary trials a method of control was framed and has been used with great success.

The method in operation is as follows:—

The bulk oil obtained in the primary distillation together with 15% from the re-distillation of inferior oil is collected into one 400 gallons tank until the tank is full; this tank will contain 400 gallons of oil having definite properties. A first charge of 50 gallons from the tank is re-distilled and a definite volume (42 gallons or 84%) of quality I oil is distilled over and condensed. An average sample of this quality I oil so obtained is tested in the laboratory and the volume distilling over below 170°C . is found. If the volume is found to be below (or above) 90% (see specification) then it follows that re-distillation was carried too far (or not far enough) by the distiller and orders are given that in the subsequent charges from the particular bulk oil tank the amount distilled over as quality I oil must be less (or more) than the amount obtained from the first charge of 50 gallons.

Great care is taken that the control test is carried out under identical conditions each time. This is of paramount importance, for by varying the conditions almost any result can be obtained.

It is intended to pass the quality I oil obtained from several bulk oil tanks into one 1,200 or 1,600 gallons tank and so average out the slight individual variations.

The benefits resulting from this method are—

- (i) The turpentine conforms to the proposed American specifications, in fact its limits are much narrower than those allowed in the American specifications, and this standard is continuously obtained.
- (ii) The yield of quality I oil is slightly higher than with the old process, (1.57 gallons per maund of crude resin as compared with 1.45). On a yearly distillation of 36,000 maunds a still, quality I oil is increased by 4,300 gallons with a corresponding profit of Re. 1 a gallon.
- (iii) A certificate of physical properties can be issued with every drum of turpentine sold. It is hoped that free issue of this certificate will go a long way towards stopping that practice of adulteration of turpentine which is so prevalent.

The utilisation of waste resinous matter.—An investigation has been made at Jallo to convert the waste resinous matter consisting of earth, pine needles, bark and wood chippings which have generally been disposed of by being burnt in the open into saleable lamp-black by consuming it in a lamp-black chamber made of unserviceable resin-tins. Crude resin contains 5% of such waste matter. It is expected that with a proper chamber 1 lb. of lamp-black will be obtained from each maund of waste material. The prices of two well known grades of lamp-black in Bombay are Re. 1-8-0 and 10 annas a lb. Turpentine of quality III and resin oil are expected to produce a very good grade of lamp-black and if this is so a new outlet for the former and for surplus resin is found.

BURMA.

Tannins.—The Government Tannin Expert Mr. Pilgrim was engaged in an investigation of the tan-stuffs of the Sunderbans between June 1919 and February 1920. It was, therefore, in the main an inquiry into the products of the mangroves. For this work Mr. Pilgrim was deputed to the Board of Industries, Bengal, and his report is being published through the latter.

He was subsequently released from his work in India to take up the duties for which he was first engaged, namely the examination of the tan possibilities of Burma. He is now busy with an examination of the oaks and chestnuts indigenous to Maymyo and its vicinity. The preliminary tests have given promising results, and considering the wealth of species and individuals of the Cupuliferae in certain parts of Burma it may be hoped that commercial development will follow these investigations.

Mr. Pilgrim writes that it will be regarded as somewhat surprising that in the Burma oaks, as a whole, the wood shows infinitely more promising results than the bark. Such are the woods of *Quercus Lindleyana*, one of the commonest oaks on the Maymyo plateau which yields an infusion which is free from any black colour, and of *Quercus spicata* var. *microcalyx*. The outer layers of the bark of the latter two and of *Quercus Griffithi* are capable of giving useful extracts with good tanning properties but much inferior in colour to those of English oaks. Another oak *Q. serrata* has given promising results from its leaves and galls. Lastly remarkably good preliminary results have been obtained from the wood of one of the commonest local trees, the chestnut *Castanopsis tribuloides*.

The Tannin Expert makes the following interesting remarks in comparing the Burma oaks with those of other countries.

"*Difference between Burma Oaks and those of Europe.*—This consists mainly in a tendency, on the part of the tannin in the former; rather to resemble that of the oak bark of Europe than that of European oak wood, in that it veers towards catechol-tannin reactions with a corresponding redder infusion than that obtained from the European wood. The tendency is quite strongly marked even in the best of these woods, *vis.*, that of *Quercus Lindleyana*, which however seems nevertheless to possess the valuable weight-giving property usually associated with oak-tannage.

"Most strongly marked of all is the catechol-tannin tendency, in the case of *Quercus fenestrata* bole-wood which indeed seems to contain at least a very large *preponderance* of tannin of the catechol class. On the other hand the wood of *Quercus Griffithii* is the one which most closely resembles English oak wood and seems to contain almost entirely *pyrogallol tannin*. It, however, does not by itself seem to be giving nearly as good-coloured a leather as the pinky-buff of the *Quercus Lindleyana*. As for its weight-giving properties I am, at the moment, unable to quote them as the tanning experiment with *Quercus Griffithii* is not yet completed. It may be mentioned, in passing, that *Quercus spicata* wood, which appears to contain equally pyrogallol and catechol-tannins, has in my small tests given the best weight so far obtained from these woods.

"It is unfortunate that, owing to the objectionable harsh leathers obtained from a number of tan-stuffs including for instance many mangroves, any tendency towards redness of even good leather is apt to be objected to by European tanners. The pink-buffs however produced by these local oaks are no worse than that which has proved acceptable in the case of the well-known and much used quebracho wood and the leather appears to have the superiority usually associated with oak. In any case a slight treatment with the local galls of *Quercus serrata* appears successfully to eliminate the pink colour and it would be open to the manufacturer, as I have stated earlier in this paper, to admix a small quantity of the galls into his Burma oak extract if he thought well. An alternative would be to prepare and sell a certain quantity of a separate galls-extract along with the oak wood extract; for use in small preparations, at the end of the tanning process.

"Comparison with some Indian oaks:—

"*Quercus incana* bole-wood (sample from the Inspector-General of Forests, Simla,) gave a theoretical yield of 8·7 % of 'crystal' extract, with a theoretical-maximum-possible percentage of tannin of 50 %. The tan is somewhat on the red side. The bark of the same species showed a yield of 20%, with a maximum possible percentage of tannin therein of 64 %. This bark gave nearly as good a result as the bark of the local Maymyo chestnut *Castanopsis tribuloides* and better than any of the local Burma oak barks so far examined.

"Oaks from the Darjeeling neighbourhood showed, as a rule, comparatively low possible percentages of tannin in the bark extract although there was one notable exception, that being the Himalayan Oak *Quercus fenestrata*, whose bark gave a 25% yield of 62 % crystals (calculated theoretical figures). I have obtained no such result from the local *Quercus fenestrata*, but I do not believe that the two species are entirely identical; and in any case locality is always likely to prove an important factor and the Darjeeling trees grow at an elevation of about double that of Maymyo. There is a similar difference, but in favour of Burma, in the case of *Castanopsis tribuloides* wood."

CHAPTER VIII.

FOREST PUBLICATIONS.

Although this branch is not yet organised it forms an integral part of a research Institute.

For reasons given elsewhere in this report the output of literary effort, memoirs, records, bulletins and leaflets of the central Institute, which alone are dealt with in this chapter, was much less than usual.

The following publications were either issued during the year or are in the Press :—

Serial No.	Name of publication.	Author.	Branch of research.
FOREST RECORDS.			
<i>Issued.</i>			
1.	Note on <i>Hopla canarensis</i> , Hole ...	R. S. Hole ...	Botany.
2.	Note on <i>Isura Butterwickii</i> , Hole ...	Do. ...	Do.
3.	Notes on the Larvæ and Life-histories of Prionine Beetles. Coleoptera, Cerambycidae, Prionine.	C. F. C. Beeson...	Zoology.
4.	The Life History of the Toon Shoot and Fruit Borer, <i>Hyphippia robusta</i> , with suggestions for its control.	Do. ...	Do.
5.	Note on the Mechanical Strength and Seasoning Properties of <i>Shorea robusta</i> Lumber.	R. S. Pearson ...	Economy.
<i>In Press.</i>			
6.	Note on Afforestation of Ravine Lands in the Etawah District, United Provinces.	E. A. Smythies ...	Silviculture.
7.	Note on the Bee Hole Borer of Teak ...	C. F. C. Beeson ..	Zoology.
8.	Note on Lac and Shellac ...	H. A. F. Lindsay and C. M. Harlow.	Economy.
9.	Note on the Regeneration of Sal Forests	R. S. Hole ...	Botany.
FOREST BULLETINS.			
<i>Issued.</i>			
10.	The Construction of Calcareous Opercula by longicorn Larvæ of the Group Cerambycini (Coleoptera, Cerambycidae).	C. F. C. Beeson...	Zoology.
11.	Note on Hollow Lumber <i>Dipterocarpus pilosus</i> , Roxb.	R. S. Pearson ...	Economy.
<i>In Press.</i>			
12.	Note on Pynma, Ajhar or Jarol Wood (<i>Lagerstrœmia Flos-Reginae</i> , Retz.)	Do. ...	Do.
13.	Note on Weights of Seeds ...	S. H. Howard ...	Silviculture.
14.	Note on <i>Adina cordifolia</i> ...	C. E. Q. Cox ...	Economy.
15.	Note on <i>Odina Wodier</i> ...	Do. ...	Do.
16.	Note on <i>Bombax malabaricum</i> ...	Do. ...	Do.

APPENDIX I.

ADMINISTRATION REPORT OF THE FOREST RESEARCH INSTITUTE,
DEHRA DUN, FOR THE YEAR 1919-1920.

Administration.—The post of Conservator of Forests which was held by the President of this Institute was converted into one of Chief Conservator with effect from 1st March 1920.

Mr. W. F. Perrée, C.I.E., held this post from 1st July 1919 to 17th April 1920 and the writer of this report from 23rd April 1920 to the end of the year while Mr. J. E. Macpherson, Personal Assistant, held charge of the current duties in the *interim*.

The names of the officers who held charge of the various branches are given below :—

Branch of Forest Research Institute.	MONTH AND DATE.		Name of officer in charge of branch.
	From	To	
Silviculture ...	1st July 1919...	20th October 1919.	Mr. W. F. Perrée, C.I.E., Conservator of Forests and President, Forest Research Institute and College.
	21st October 1919.	30th June 1920	Mr. S. H. Howard, B.A., Deputy Conservator of Forests United Provinces.
Forest Botany ...	1st July 1919...	25th November 1919.	Mr. C. F. C. Beeson, M.A., Deputy Conservator of Forests, (Punjab) and Forest Zoologist.
	26th November 1919.	30th June 1920	Mr. S. H. Howard, B.A., Deputy Conservator of Forests, United Provinces.
Forest Economy	1st July 1919...	26th August 1919.	Mr. R. S. Pearson, F.L.S., Deputy Conservator of Forests, (Bombay).
	27th August 1919.	6th November 1919.	Mr. C. E. C. Cox, Deputy Conservator of Forests, Central Provinces.
	7th November 1919.	11th March 1920	Mr. A. J. Gibson, F.L.S., F.C.H., Deputy Conservator of Forests, (Punjab).
	12th March 1920	30th June 1920	Mr. C. E. C. Cox, Deputy Conservator of Forests, Central Provinces.
Forest Zoology...	1st July 1919...	25th November 1919.	Mr. C. F. C. Beeson, M.A., Deputy Conservator of Forests (Punjab).
	26th November 1919.	6th February 1920.	Mr. J. E. Macpherson, Personal Assistant to President, Forest Research Institute and College.
	7th February 1920.	30th June 1920	Mr. F. M. Howlett, Imperial Pathological Entomologist of Punjab.
Forest Chemistry	1st July 1919 ...	14th November 1919.	Dr. J. L. Simonsen, D.Sc., F.I.C.
	15th November 1919.	7th March 1920	Mr. A. J. Gibson, F.L.S., F.C.H., Officiating Conservator of Forests (Punjab).
	8th March 1920	30th June 1920	Dr. J. L. Simonsen, D.Sc.

Establishment.—The absence of Mr. R. S. Hole (Forest Botanist) throughout the year, and of Messrs. R. S. Pearson (Forest Economist), C. F. C. Beeson (Forest Zoologist) and of Dr. J. L. Simonsen (Forest Chemist) during parts of the year was the cause of these numerous changes and necessitated the President and certain of the Research Officers holding charge of other offices in addition to their own. With the return of the heads of branches from leave the position will improve in 1920-21 and the work of all the branches be in full swing by the end of it.

The post of Personal Assistant to the President was created during the year and Mr. J. E. Macpherson, on relief from military service, was appointed Personal Assistant with effect from the 16th October 1919.

Under the new reorganisation, five members of the Institute who as assistants in various branches have done some years of honourable work, were given gazetted rank, the promotion dating from 1st March 1920. Messrs. B. L. Gupta, Abdul Hafiz Khan (Botany), Gurdit Singh (Silviculture) and Nivaran Chandra Chatterjee (Zoology), were put in the new grade of Rs. 250—20—550 and Mr. Tarak Prashad Ghose (Chemistry) in the grade of Rs. 210—10—400.

Sanction to the revision of the major portion of the clerical and the menial service was received during the year, but in consequence of the continued high costs of living and the rise in salaries which have recently been granted to corresponding establishments in the Punjab and the United Provinces the question of further increase of pay of the clerical, subordinate and menial establishments is under consideration.

Buildings.—No new work was undertaken during the year but existing buildings were kept in repair. Much time was spent by the senior officers of the Institute in considering the acquisition of the new site, the lay-out and, in a few cases, the plans of buildings for the new Research Institute.

Fittings and Furniture.—Little expenditure on this head was incurred during the year except that the equipment of the chemical laboratory has been improved very considerably. The students of the Provincial Forest Service and Ranger classes are at present badly equipped for the practical study of Chemistry, Physics and Engineering.

Research Offices.—The standard of work in all the offices was well maintained. Work tends to grow, especially in the President's office, and with the large amount of organising work looming ahead, particularly in the Economic branch, some increase of clerical staff appears inevitable. As regards the President's office the situation will be clearer if, as is hoped, the Ranger classes and College are handed over to the United Provinces on 1st April 1921.

Grounds.—The labelling of the trees and shrubs in the Forest Park and College grounds requires and is receiving attention.

Library.—Further additions have been made to the central as well as to sectional libraries. Steps are being taken to provide the Chemical Branch with an up-to-date library. The number of books and periodicals on the registers of all the libraries on 30th June last stood at 6,848 and 7,764 respectively.

Work of Officers.—In spite of the temporary paucity of staff all the officers on duty, both the heads of branches and their assistants, have done their very best to keep up the standard of work and to give all the assistance which was asked in lecturing to and even taking charge of classes of students. Mr. C. E. C. Cox severed his long connection with the Institute and took back to the Central Provinces the good-wishes of his fellow-workers. Messrs. Pearson and Beeson spent much of their time out of India in furthering the work of their branches, namely in purchasing plant and improving the connection of this Institute with other similar bodies and with experts and specialists in Europe and America. The importance of such connection and co-operation cannot be over-estimated.

APPENDIX II.

FINANCIAL.

The expenditure of the past two years is compared below :—

					Expenditure during the year.		Difference + or —
					1918-19.	1919-20.	
AVI.	Stores, Tools and Plant	...	...	Rs.	Rs	Rs.	
				5,281	8,328	+3,247	
AVII.	Buildings, etc.	...	...	3,163	3,820	+657	
AIX.	Miscellaneous	...	...	13,677	35,972	+22,295	
Bla.	Conservators	...	...	11,307	18,956	+7,689	
BIb.	Superior Officers	...	...	71,757	58,866	-12,891	
BIc.	Subordinate Forest and Depôt Establish- ment.			13,776	12,736	-1,040	
BI d.	Office Establishment	...	...	25,781	32,518	+3,737	
BIe.	Deputation and special allowances	...	...	13,802	9,524	-4,278	
BI f.	Compensation for dearness of provisions	...	...	1,640	1,606	-34	
BII.	Travelling allowances	...	...	15,522	16,558	+1,036	
BIIL.	Contingencies	...	...	11,555	17,346	+5,791	
Total					1,90,061	2,16,270	+26,209

The increase under AVI is due to the purchase of machinery for the Economic Branch.

The increase under AVII is due to high rates being paid for labour.

The increase under AIX is mainly due to the cost of the illustrations of Mr. Leete's report on Lumbering and Wood Working Industries of the United States of America and Canada being charged to this head and in a less degree to the purchase of more chemicals for the Forest Chemist and to a larger expenditure having been incurred on experiments by the Forest Economist and Tannin Expert and as well as to the entertainment of a surveyor on daily labour for survey of the new Research Institute site.

The increase under B1a is due to the elevation of the President's post to that of a Chief Conservator of Forests and to the appointment of Mr. A. J. Gibson, officiating Forest Economist as officiating Conservator of Forests.

The decrease under B1b is due to the absence on leave of Messrs. R. S. Hole and C. F. C. Beeson and to no other officers having been appointed from outside to fill their places.

The increase under B1d is due to the reorganisation of the Clerical, Miscellaneous and Menial Establishments having been brought into force with effect from 15th July 1919.

The decrease under B1e is due to the departure of Messrs Hole and Beeson on leave and to no retaining fee having been paid to Mr. W. Raitt, Paper Pulp Expert.

The increase under B1f is due to extensive tours having been undertaken by the President and the Silviculturist.

The increase under B1g is due to the purchase of a large number of books for the Forest Chemist and to the binding of more books than usual.

APPENDIX III.

List of Forest Publications issued since the creation of
the Forest Research Institute.

I.—BULLETINS (OLD SERIES).

PRICE
(exclusive of
packing,
postage, etc.)
Rs. a. p.

- 1.—Note on the Bee-Hole Borer of Teak in Burma, by E. P. Stebbing. (*Out of print*) ... 0 4 0
- 2.—Note on the Quetta Borer (*Zeolestes sartus*), by the same author. (*Out of print*) ... 0 8 0
- 3.—Note on the Chilgoza (*Pinus Gerardiana*) Bark-Boring Beetles of Zhob, Baluchistan, by the same author. (*Out of print*) ... 0 8 0
- 4.—*Ficus eldsica*: its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry ... 0 12 0
- 5.—Notes on a Visit to some European Schools of Forestry, by E. P. Stebbing ... 2 0 0
- 6.—Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett ... 0 2 0
- 7.—Note on the Chilgoza Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing (*Out of print*) ... 0 12 0
- 8.—Note on the Life-History of *Hoplocnemys spinicornis* (The Singbhum Sal Borer), by the same author ... 0 9 0
- 9.—Note on the Influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Willmot ... 1 0 0
- 10.—Note on the Duki Fig-Tree Borer of Baluchistan (*Batocera rubus*); by E. P. Stebbing ... 0 7 0
- 11.—On Some Assam Sal (*Shorea robusta*), Insect Pests, by the same author ... 1 10 0

II.—LEAFLETS.

- 1.—The Sal Bark-Borer (*Sphaerotypus siwalikensis*, Steb.), by E. P. Stebbing. (*Out of print*) ... 0 4 0
- 2.—The Teak Defoliator (*Hyblaea putra*, Cram.), by the same author. (*Out of print*) ... 0 2 0
- 3.—The Teak Leaf Skeletoniser (*Pyrausta macharalis*, Wlk.), by the same author. (*Out of print*) ... 0 2 0
- 4.—The Larger Deodar Bark-Borer (*Scolytus major*, Steb.), by the same author. (*Out of print*) ... 0 4 0
- 5.—The Blue Pine "Polygraphus" Bark-Borer (*Polygraphus major*, Steb.), by the same author. (*Out of print*) ... 0

III.—PAMPHLETS.

PRICE
(exclusive of
packing,
postage, etc.)
Rs. a. p.

1.—Note on Utilization of Khair Forests in Eastern Bengal and Assam, by Purn Singh. (<i>Out of print</i>)	...	...	...	0	4	0
2.—The Attack of the Bark-Boring Beetle in the Coniferous Forests in Simla Catchment Area, by E. P. Stebbing	...	...	...	0	8	0
3.—A Glossary of Forest Technical Terms for Use in Indian Forestry, by A. M. F. Caccia (<i>Revised and issued as Bulletin No 4, New Series</i>). (<i>Out of print</i>)	...	...	...	0	4	0
4.—Note on Lac and Lac Cultivation, by D. N. Avasthi	...	...	...	0	2	0
5.—Notes on Sal in Bengal, by A. L. McIntire. (<i>Out of print</i>)	...	...	...	0	4	0
6.—Note on Forest Reservation in Burma in the Interests of an Endangered Water-Supply, by A. Rodger	...	...	...	1	0	0
7.—Note on Andaman Marble Wood or Zebra Wood (<i>Diospyros Kurzii</i> , Hiern.), by R. S. Troup	...	...	...	0	4	0
8.—Note on the Collection of Statistical Data relating to the Principal Indian Species, by A. M. F. Caccia	...	...	...	0	10	0
9.—Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December 1902, by the same author	...	...	...	0	10	0
10.—Note on Burmese Leza Wood (<i>Lagerstramia tomentosa</i> , Presl.), by R. S. Troup	...	...	...	0	2	0
11.—Note on Carallia Wood (<i>Carallia integrifolia</i> , DC.), by the same author	...	...	...	0	2	6
12.—Note on Petwun or Trincornall Wood (<i>Berrya Ammonilla</i> , Roxb.), by the same author	...	...	...	0	4	0
13.—Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author	...	...	...	1	0	0
14.—Note on Burma Padouk (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author	...	...	...	1	0	0
15.—Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-Borer," by E. P. Stebbing	...	...	...	0	7	0
16.—Note on the Best Season for Coppice Fellings of Teak (<i>Tectona grandis</i>), by R. S. Hole	...	...	...	0	4	0

IV.—BULLETINS (NEW SERIES).

1.—Note on Calorimetric Tests of Some Indian Woods, by Purn Singh	...	...	...	0	2	0
2.—Memorandum on Teak Plantations in Burma, by F. A. Leete	...	...	...	0	10	0
3.—Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	...	...	...	0	4	0
4.—Second Edition of the Glossary of Technical Terms for Use in Indian Forestry, by A. M. F. Caccia, revised by R. S. Troup	...	...	...	0	6	0
5.—The Blue Pine Toxicus Bark-Borer (<i>Toxicus Ribbentropfi</i>), by E. P. Stebbing	0	2	0
6.—Memorandum on the Oil-Value of Sandalwood, by Purn Singh	0	2	0
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